

Interim Progress Report

**Engaging Agricultural Communities in the Great Plains of the
United States with the Applications and Developments of
Climate Prediction and Information**

(NOAA Project GC02-181)

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I. Preliminary Materials

A. Project Abstract

This proposal details a plan by researchers at the University of Nebraska-Lincoln to conduct a series of workshops and surveys, and develop and analyze a decision-behavioral model to understand: (1) how the effects of climate variability are perceived as represented in climate forecasts and products used by producers in three agroecozones representing different grain production regimes, rainfed, irrigated, and a mix of both in the western Corn Belt/eastern Nebraska area; (2) what are the attributes entering producers' thinking and their interplay to formulate producers' intentions and decision to act on and use or not use climate forecasts; and (3) how we can improve climate education and accordingly modify climate forecasts and products so to increase the effect of climate forecasts in farmer's thinking and decision-making. The goals are to raise the value of climate forecasts and products and, thus, climate research in the agricultural communities in the Great Plains, with the goal of reducing their vulnerability to climate risks in a changing environment.

The specific objectives of the project are to: (1) identify those agricultural activities most sensitive to climate variability in the study area and determine how the application of climate forecasts and products (or improved products) would help producers optimize production and profit; (2) develop evaluation devices and methods to gather information and understand those factors that agricultural producers consider when making decisions with climate products, relative to their farm landscape and inherent climate variability and those social, environmental, and economic constraints that affect the way producers formulate climate forecasts in making their decisions; (3) use materials gathered in (2) and develop a model that will quantify the probability for producers to act, and the extent to which they act, due to climate products influencing their decisions; and (4) develop a continuous monitoring system to update our understanding of the evolution of producers' thinking process over time, particularly, changes in the probability of using climate forecasts/products and their perception of the use of these products in their decisions after major climate events. This system will provide data to update the model developed in (3) and from this analysis to find adjustments for climate predictions and ways to improve predictions. This system can be used as a protocol for expanding this methodology into other counties in Nebraska and other states in the Great Plains region.

These objectives and goals are attainable in the proposed time frame because of existing substantial understanding of the agroecozones in the region and the characteristics of the farmers' communities. We have accumulated experience in successfully conducting surveys and workshops of various scales, and also have developed decision and behavioral models. With the basis of good understanding of the problem, our integration of multidisciplinary knowledge and experience warrant a successful project.

B. Specific Objectives of This Project

1. To identify the two prerequisites discussed previously for representative counties in the three agroecozones (i.e., the agricultural activities in these areas mostly impacted by climate variation/anomaly), and skillful climate forecasts/products that, after proper use or improvement and use, will provide producers with better tools to capitalize on favorable climate conditions or reduce the impacts of adverse climate conditions to optimize production and profit.
2. To develop evaluation devices and methods to gather information and understand those factors that producers consider when making decisions with climate products, relative to their farm landscape and inherent climate variability and those social, environmental, and economic constraints that affect the way producers formulate climate forecasts in making their decisions.
3. To use materials gathered in 2) and develop a model that will quantify the extent to which the producers will act on using various climate products (e.g., 60-day or 90-day forecast) and complete a particular task (e.g., to plant a drought resistant crop like sorghum or to purchase a particular variety or combination of varieties [fast maturing variety vs. high yield variety] of corn for the next growing season).
4. To develop a continuous monitoring system to update our understanding of the evolution of producers' thinking process over time, particularly, changes in the probability of using climate forecasts/products and their perception of the use of these products in their decisions after major climate events. This system will provide data to update the model developed in (3) and from this analysis to find adjustments for climate predictions/products and ways to improve them. This information will help engage producers in using these predictions. This system can be used as a protocol for expanding this methodology into other counties in Nebraska and other states in the Great Plains region.

C. Approach

There are two steps in taking an action with regard to using climate forecasts/information in agricultural decisions. First, farmers form an intention to use a forecast and, second, carry out the intention. We will refer to this two-step process as the decision-making process. It involves weighing many factors. They can be categorized into four groups: 1) the pursuit of self-interest, 2) the pursuit of other-interest, a kind of community or common interest, 3) political and physical environmental constraints and outside influences, and the personal ability to do, and 4) the biophysical situation represented in a particular agroecozone. By weighing these factors, an intention is formed in a person's mind to take an action. Whether this intention is executed as an economic action depends on further evaluation of personal ability and capability.

Climate forecasts are one of the factors and it has three attributes in this decision-making: 1) it provides a possible future physical environment the farmer's operation will be in, 2) a farmer can benefit from forecasts but needs adequate knowledge and skill to understand and use them, and 3) forecasts have intrinsic uncertainties and, therefore, consequences the farmer should consider. Also, there is a community dimension in using forecasts, in that others in the communities laying claim on a producer's actions may not see forecasts as useful tools. It remains unknown as to how the self and community (others) interest interacts, and how outside influences affect producers' thinking and decision-making, and, in conjunction with abilities, affect actual action. We will provide insights on this question and quantitative tools to measure how farmers in the study areas develop their intention to use or not use climate forecasts in making their farming decision and what factors raise the probability for them to take actions of using this information. We will develop and analyze a decision-behavioral model building on previous work by principal investigators of this project and others. Mathematically, if we posit $I_S(A; L)$ reflecting a farmer's self-interest in applying a climate forecast, L , with ability, A (e.g., his/her knowledge and skill of using climate forecasts), $I_C(A; L)$ the farmer's community-interest in using the same forecast in a decision, $I_A(L; A)$ the interest in the outside influence and ability factor associated with using the specific forecast L , and influence of the biophysical situation on a farmer's intention to use L , $I_Z(L; Z)$, our theories interpret that the possibility for the farmer to decide *and* use L may be determined by:

$$\Phi = B_S I_S(A; L) + B_C I_C(A; L) + B_A I_A(L; A) + B_Z I_Z(L; Z) + B_D [I_S \times I_C] + B_1 [I_A \times I_S] + B_2 [I_A \times I_C] + B_3 [I_Z \times I_A] + B_4 [I_Z \times I_B] + B_5 [I_Z \times I_C] + \varepsilon. \quad (1)$$

In (1), Φ is the probability of taking an action, and the coefficients, B , weigh the effect of each factor and their interaction on intent and actual action. To develop this model, we will use survey methods to gather information and determine the coefficients in (1) using a least-square regression method along with variance analysis.

The survey questions will be designed based on the theoretical framework of Ajzen and Fishbein to obtain adequate information on attributes entering agricultural producers' decision-making and for determining the coefficients in (1). These questions will be brought to focus group meetings and workshops in study counties and revised and amended for both easy understanding for producers and accuracy in describing the relevant decision processes. After finalizing the survey, we will conduct a mail survey in study counties in different agroecozones. Answers to survey questions will be analyzed to develop the model (1). After the model is developed, it will be analyzed to understand what role climate forecast has played in farming decisions, and what may be changed, e.g., improving agricultural producers' ability of interpreting forecasts and/or imposing policies favoring producers' use of climate forecasts, in order to raise the frequency of using forecasts and using them correctly in decisions.

Because thinking is a dynamic process, producers' intention of using or not using climate forecasts and their perception of climate effect changes with time as personal knowledge, information technology, and forecast skills improve. It is important to know how each of these attributes influences a producer's decision-making so that future effective programs can be developed to improve use of climate forecasts and information. For this reason, we will develop an Internet survey tool, which will be used repeatedly on annual basis to monitor and understand decision-making related to use of climate forecasts.

D. A Description of Matching Funds Used for This Project

Collaborative Interdisciplinary Projects

Spurred by this NOAA project, this research team also received multiple awards from the National Science Foundation and USDA Risk Management Agency to construct new geospatial decision support systems that can help farmers to make decisions regarding cropping and tillage systems and given drought scenarios. The research of this NOAA project directly supports efforts in building drought decision support systems that farmers, Cooperative Extension, agribusiness, and USDA agencies can use to evaluate current and historical drought events, as documentation to crop insurance claims and mitigation of high risk regions. The listening forums provided “rules of thumb” that the farm community follows in planning and mitigating events. In addition, the farmer discussions identified the sources of climate information, types of analyses that are understood and relied upon, and the information needs given changes in management practices and technology. The research into human behavior, attitudes, and beliefs as they relate to climate information, have led to major changes in the design, types of geospatial analyses, and delivery paths of the other projects. Collectively, this NOAA project has been matched with nearly \$2.5 million in competitive grants through the efforts of this research team.

The National Science Foundation (NSF) Digital Government Program has provided this research group with an award to support drought research in collaboration with the USDA Risk Management Agency (RMA) that will be implemented in Nebraska and the Great Plains. The award provided funding of \$498,533, \$249,589, and \$259,972 over three years, beginning last July. We believe that components (drought index models and vulnerability mapping) of the NSF supported research will be transferable in developing the drought and fire-monitoring framework for the selected national monuments and parks. The drought index models (SPI, PDSI, and the NSM) provide multiple time windows to evaluate the intensity and magnitude of events, which translates into map products that can represent near real-time conditions and the historical climate context (often back to the 1890’s for Nebraska weather stations). These drought index tools can be found at our web page: <http://nadss.unl.edu>.

In addition to the NSF Digital Government Program, this research group received an award from the USDA Risk Management Agency to support “Risk Assessment and Exposure Analysis on the Agricultural Landscape--A Holistic Approach to Spatio-Temporal Models and Tools for Agricultural Risk Assessment and Exposure Analysis.” This project was funded for \$1.3 million over 2 years and provides for the development of drought risk assessment tools tailored to farmers and ranchers, as well as USDA/RMA crop insurance programs.

USDA/RMA also supported a series of drought workshops throughout Nebraska in an award (\$95,198) through their Targeted Commodity Partnerships for Risk Management Education. These workshops were held at 5 locations across Nebraska at regional colleges and extension centers to address persistent drought conditions, crop insurance strategies in multi-year droughts, historical climatology, and El Nino/La Nina impacts on crop production.

This research group also recently received another award from NSF’s Information Technology Research program for a project entitled “Intelligent Joint Evolution of Data and Information: An Integrated Framework for Drought Monitoring and Mitigation Support”. This project has been funded for two years with a total award of \$200,000 to build an integrated hydrological drought (stream gauges, lake stages, and groundwater wells) framework that views droughts through various windows that can provide higher resolution, better detect emergence

and closure of events, as well as their spatio-temporal impacts. A key outcome of this project is the integration of National Weather Service and High Plains Regional Climate Center weather station networks, USGS stream gage and groundwater monitoring sites, and USDA geospatial natural resource databases into a coherent picture of hydrologic drought in the Great Plains and impacts on natural ecosystems.

Through a Memorandum of Understanding with the USDA National Agricultural Statistics Service, we developed the 2002 Cropland Data Layer for Nebraska. This remotely sensed datalayer from Landsat 7+ characterizes the crop types (corn, soybeans, milo) at 30 m resolution. This crop cover represents a key base layer for metrics of crop diversity, drought vulnerability mapping, and estimating agricultural water demand in an agricultural decision support system. This project will be repeated during the 2003 cropping season. This is a unique collaboration with USDA/NASS, which has not had a tradition of working with land grant universities, but it represents a significant amount of data sharing (Landsat 7+ and NASS segments) and analysis to benefit agricultural communities in Nebraska without major funding. A key outcome to this relationship is the expanded collaboration with other UNL departments, such as Agronomy & Horticulture and Agricultural Economics, as well as the National Drought Mitigation Center.

Other Matching Funds

Several project members have devoted more than double of their time originally budgeted for the project. The salary and fringes associated with the extra time on the project may be considered as matching funds. In addition, our secretaries have provided a lot of support for no pay from this project. Their time and associated salary and fringe also are matching funds for this project.

II. Interactions

A. Interactions with Decision Makers (who were either impacted or consulted as part of this study)

Three focus groups were organized in Otoe, Seward, and Fillmore County in Nebraska on November 19, November 21, and December 12, 2002, respectively. A total of twenty-eight agriculture producers attended the focus groups (eight in Otoe, ten in Seward, and ten in Fillmore). Some pictures of focus groups are shown at our project website <http://snrs.unl.edu/noaa-hdgc/progress/progressreport.html>. Participants were guided by a facilitator/coordinator from the project team and discussed what decisions were made in different stages of a growing season; how those decisions were made, e.g., were they made based on tradition, habits, or other factors; and any climate information/forecast that was used in making those decisions. Additional questions discussed in the focus groups included: why did the producer(s) use particular forecasts or climate information? Where was the climate information/forecast obtained? Was any benefit received from using the climate forecast? Were there decisions made without using climate forecasts but could have benefited from using the forecast? In addition to discussing forecast use, other subjects also were brought to the meeting, including how self-interest vs. community interest was influencing use of climate forecasts in agricultural decisions. Specific questions were: What did agricultural producers' neighbors and bankers think the producers should do regarding use of climate forecasts? Were the environment and community welfare factors considered in decision-making? Were they promoting the producers' use of specific climate forecast information in, e.g., applying pesticide, herbicide, and other chemicals, and in use of water resources? Extension educators in those three counties attended the focus groups and engaged in the dialogue.

Focus group attendees were active in participating in the discussions and made valuable input to our knowledge of how they have perceived and used climate forecasts. After these focus groups we drafted the first version of our survey and brought it back to the extension educators from the three counties in a meeting on January 24, 2003, and then to the same group of producers in Otoe County in a meeting on January 31, 2003. During the mail survey, we also interacted with individuals who had questions with the survey and also those who wanted to express their feeling and concerns on issues raised in the survey questions.

B. Interactions with the Climate Forecasting Community

Initial contacts were made and conversations engaged on the subject at a professional conference with Drs. Y.J. Zhu and J. Du of NOAA CPC. CPC's Senior Meteorologist Douglas Comte met with some members of our team on June 3, 2003, and also helped engage our communications with CPC on results from this project.

C. Coordination with other projects of the NOAA Climate and Societal Interaction Division

No activity has been engaged in this area.

III. Accomplishments

A. Research Tasks Accomplished

From August through September 2002, the project team discussed and analyzed the best strategy to design the conceptual model for understanding agricultural producers' decision-making related to use of climate forecast and information. These discussions and interactions among the project scientists in diversified disciplines (social economics, psychology, social psychology, climate science, and agronomy) improved the teams' understanding of alternative theories and approaches to understanding decision-making related to use of climate forecasts and helped. This interaction helped us to synthesize and fuse knowledge from the different disciplines and form the theoretical foundation on which this research is to be built.

With this synthesized knowledge base, we proceeded and identified the categories of survey questions that will extract information of various attributes in decision-making, from personal belief, preference, and value of community interest vs. self interest; ability to interpret and use climate information and forecasts; financial ability to manage potential losses from use of inaccurate forecasts; to past habits and personal traits affecting the perception and influence of forecasts. Subsequently, a set of questions were designed for each category and answers to those questions are expected to supply the necessary pieces of information to measure effects of the individual attributes on decisions related to use or not use climate forecasts.

While designing these questions, we conducted three focus groups in the three study counties in eastern Nebraska (see II-A above). In these focus groups, we interacted with crop, including fruit, producers, as well as ranchers and gathered specific agricultural decisions whose outcomes can be very different if correct climate forecasts influence decisions. We discussed with the focus groups if climate forecasts influenced their making agronomic, cost, marketing and community (e.g., sharing irrigation water during drought) decisions and why forecasts were used or not used in their decision-making. Based on these interactions and understanding of actual decision-making, we designed our preliminary survey instrument. This instrument was brought back to the focus groups and extension educators to obtain their feedback on relevancy and accuracy of each of the questions in the instrument, their complexity, and sensitivity to producers answering the questions. After iterating in several rounds on each of the questions, we finalized our survey instrument, differing by county only with respect to the map. A copy is included in this report.

After designing the survey, we collected and digitized names and postal addresses of agricultural operators in Otoe, Seward, and Fillmore Counties through working with the county offices of the USDA Farm Services Agency. The digitized names and postal addresses and survey instrument were sent to the Center for Information Technology (CIT) of the University of Nebraska, where the surveys were printed along with a cover letter introducing the survey and the importance to complete and return it. The instrument was mailed to 66 percent of the operators on March 5. The mailing of a postcard reminder to the 66 percent and the instrument to the remaining 34 percent was done on March 24. Because of both the complexity and size (number of questions) of the survey and the uncertainty in producers' interest in such survey related to weather and climate forecasts, we adapted a suggestion from the focus groups and decided, and also stated in the survey cover letter, that producers who completed the entire survey would receive \$25 as an honorarium.

The return rate of the survey as well as the percentage of people requesting payment is summarized in Table 1.

Table 1: Survey Statistics.

	FILLMORE		OTOE		SEWARD		Total	
	Questionnaires	Vouch	Quest	Vouch	Quest	Vouch	Quest	Vouch
Number	189.00	170.00	259.00	224.00	276.00	236.00	724.00	630.00
Response/proportion	38.5%	34.6%	30.6%	26.5%	31.6%	27.0%	32.7%	28.5%
Proportion requesting \$		89.9%		86.5%		85.5%		87.0%

Table 1 shows that Fillmore County, which generally has the highest technology use in agricultural production among the three counties, has the highest survey return rate of nearly 39%. On the other hand, Otoe County which is characterized by more traditional farming practices has a relatively low return rate close to 31%. The average return rate of the three counties is about 37%. An average of 87% of people completing the survey requested for payment.

After receiving survey returns, we hired three undergraduate students to digitize the survey results. The digitizing was supervised by Dr. Gary Lynne and Mr. Ikrom Artikov, an MS student working on this project, with substantive attention paid to ensuring the quality and integrity of the data entry process. At this time, the digitizing work has been completed and the survey data has been entered into the SPSS software for analysis. Another undergraduate student was hired and worked under the supervision of Dr. William Waltman to establish a georeference database for agricultural producers participating in the survey, based on locations highlighted on the map in each questionnaire. This database will be used in our analysis to examine how variations in attitude and decisions toward use of climate forecasts may be influenced by differences in environment of the agroecozone across the region. Figure 1 in section V-B shows the geographical distribution of the dataset, depicting the geographical locations of the producers in the three counties. (Some Otoe County farmers misunderstood the map attached to the survey and marked their farm locations outside the north and south county boundaries. We are correcting this problem.)

Concurrently with the progress in mail survey, we also have developed a web-version of our survey. We are currently negotiating for a host machine for the web-survey and, after finding a host, will make the survey available to the program office. Copies of two pages of the web-survey are shown in Figs. 2 and 3 in section V-B. This web-survey is developed for the purpose of conducting a repeated survey with the same questions and among the same population in a sequence of future years. From examining the survey results, we will be able to identify the dynamic processes in decision-making related to use or not to use a climate forecast. This time sequence will help in revealing how various factors, e.g., improving forecast accuracy, change in government policies in farming and environment, subsidies and crop insurance, and major climate events, droughts and floods, may change the beliefs, desires, attitudes and intention to use more (or less) forecasts in decision making.

B. Summary of Preliminary Findings

Some preliminary statistics of producers' perceptions on weather and climate forecasts and their usefulness in farming decisions are shown in the following figures. These statistics, based on the survey results, highlight the importance of the forecasts in various decisions in agricultural productions in the surveyed counties.

Figure III-1 shows the percentage of surveyed producers who used current and recent past growing season rainfall in their area to make decisions for the coming growing season. For psychological reasons people tended to place more trust in their experience with the recent weather and climate than on forecasts. This result confirms this notion and shows that a majority of the surveyed producers looked at the current and recent past climate conditions in considering their farming decisions.

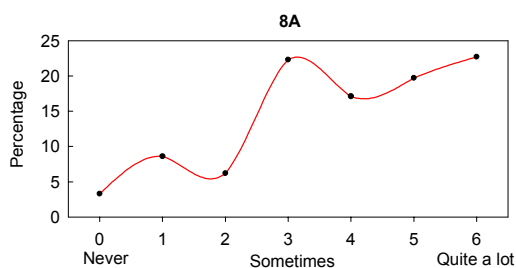


Fig. III-1: Use of current and past growing season rainfall in your area to make decision for the coming growing season.

Figure III-2 shows the percentage of surveyed producers who look at short-term (1-2 day) forecasts of temperature and rainfall. It is interesting that almost all the surveyed used the short-term forecasts and one out of two used the forecasts “quite a lot.” This result may be partially attributed to the higher accuracy of the short-term

forecasts. The result is encouraging to NOAA forecast makers.

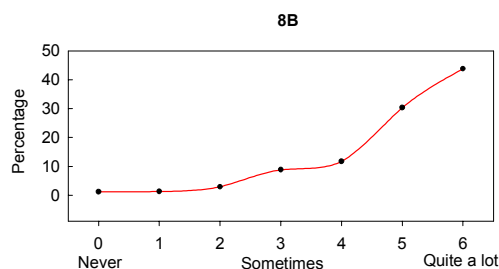


Fig. III-2: Percentage looking at 1-2 day forecasts of rainfall and temperature.

Compared to Fig. III-2, the distribution for use of medium range (8-14 days) and seasonable forecasts in decision-making is different (Figs. III-3 and III-4). Although about equal numbers of producers used medium and seasonal forecasts a large portion of the users are in the “sometimes” category. The various reasons causing these differences are under investigation (based on answers to other questions in the survey), but one of them has been identified to be the accuracy of the forecasts. At what accuracy or under what understanding of the accuracy, and thus risk, will the long-term forecasts gain a higher frequency of usage? This is one of the key questions we are addressing.

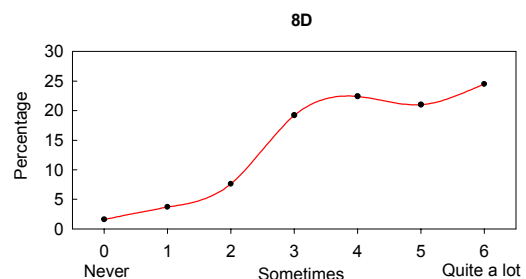


Fig. III-3: Percentage who look at the 8-14 day forecasts of rainfall and temperature.

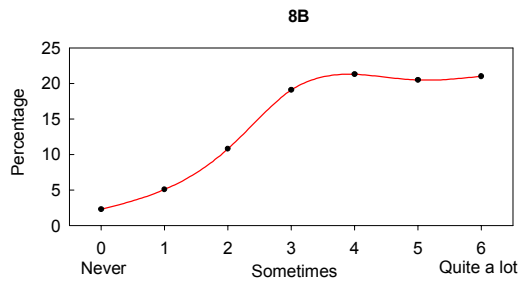


Fig. III-4: Percentage who look at the seasonal forecasts.

Figure III-5 shows producers' attitude of "letting weather forecasts influence their crop related decisions." Majority of the producers have the belief that climate forecasts are "somewhat" to "quite" useful, although the percentage in the "very" useful (scale 6) category is low.

Figure III-6 describes percentage of producers who think of the use of forecasts in deciding right amount of crop insurance. Although the past experience of "looking at" forecasts and being influenced by them occurred in about 20% of the decisions, the desire of producers to use forecasts in their climate sensitive decisions remains high (Figs. III-7-8), warranting great effort to improve the forecasts and strategies to use them.

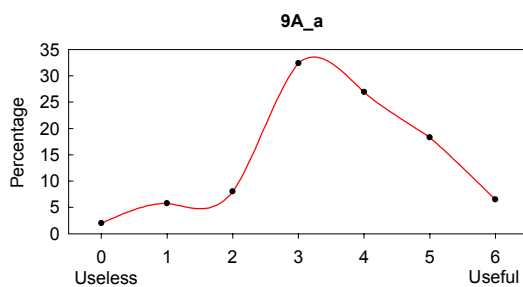


Fig. III-5: Letting weather forecasts and information influence your crop related decisions.

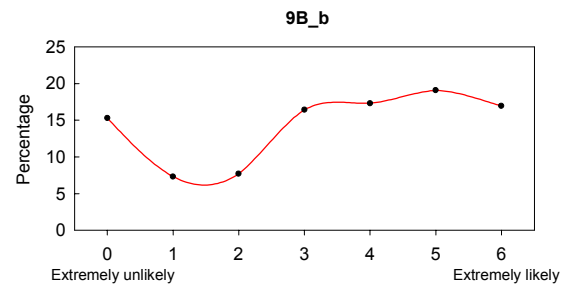


Fig. III-6: Percentage who think of use of the long-term forecasts in decision of right amount of crop insurance.

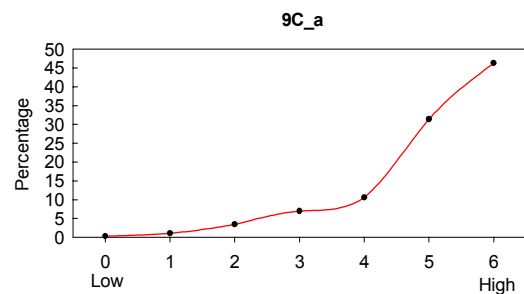


Fig. III-7: Percentage who *value* the long-term forecasts in decisions of planting the best crops.

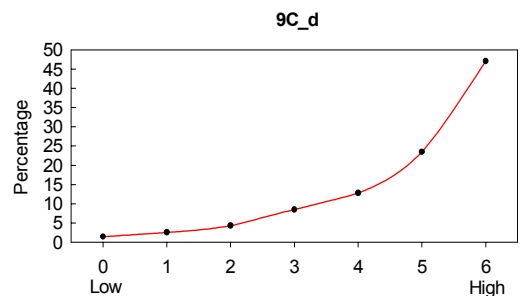


Fig. III-8: Percentage who *value* the long-term forecasts in decisions of maximizing crop revenue in marketing.

C. List of Papers and Publications

We have been in communication with the Editor in Chief of the *Bulletin of the American Meteorological Society* (BAMS), Dr. Jeff Rosenfeld, to submit two articles to the BAMS. These articles will introduce the work of this project to the American Meteorological Society, will illustrate the theory of planned behavior and its application to understanding why agricultural producers do or do not use climate forecasts in their decision-making; will present some quantitative results from our survey and show the producers' perception and action of using climate forecasts; and finally will discuss options to improve the use of climate forecasts in agricultural communities in the central United States. The abstracts of the two intended articles are in the following.

The Theory of Planned Behavior: Understanding the Use of Climate Forecasts and Information

Alan J. Tomkins, Gary D. Lynne, Lisa PytlikZillig, Stacey Hoffman, Q. Steven Hu, William J. Waltman, Michael J. Hayes, Kenneth G. Hubbard, and Donald A. Wilhite
University of Nebraska-Lincoln
June 2003

Abstract

This article is an attempt to help meteorological and climatological scientists improve use of climate forecasts and information by agricultural producers. It shows how a leading theory from the psychological sciences, the Theory of Planned Behavior, will help researchers select and measure relevant variables that will provide insight into producers' use of forecast information. In addition to forecasting, examples of applications of the Theory of Planned Behavior to other relevant domains are presented. The social psychological Theory of Planned Behavior provides meteorologists and climatologists the possibility of explaining substantial proportions of variance of target behaviors (e.g., planting, applications of fertilizer) and allows the comparison of the use of forecast information to other factors that influence the way that producers act. It also will allow meteorologists and climatologists to learn the extent to which their products are being used, or not used.

Use of Climate Forecasts and Information by Agricultural Producers: The Current Situation and Indications

Q. Steven Hu, Gary D. Lynne, Lisa PytlikZillig, William J. Waltman, Michael J. Hayes,
Alan J. Tomkins, Kenneth G. Hubbard, and Donald A. Wilhite
University of Nebraska-Lincoln
June 2003

Abstract

In order to reduce climate risks to the economy, and benefit social welfare, it is critical to improve the use of climate forecasts and information by decision-makers. In this effort, it is essential to know how and why climate forecasts and information are used in decision-making.

These measures provide guidance to both the research and design of strategies and policies to increase application of the forecasts. In this study, a survey was conducted to measure the use of climate forecasts by agricultural producers in three counties in eastern Nebraska. Survey results show the frequency when producers “looked at” various climate information and forecasts and the extent to which the forecasts affected producers’ agricultural decisions, which range from seed selection, planting strategy, crop insurance amount, management procedures during crop growth, and harvest. In addition, the survey results indicate that besides the accuracy of forecasts another major factor that undermines forecast influence in agricultural decision-making is the “reliability of the source of forecasts,” in other words, lacking an identification of sources responsible for a forecast. Suggestions are provided for improving these issues so that climate forecasts and information can play a bigger role in decision-making by agricultural producers.

D. Discussion of Significant Deviations

The only deviation in the project is our use of Fillmore County in the project instead of Clay County as originally planned. This was due to the influence of budget cuts on Clay County Cooperative Extension and our difficulty in finding extension educators in that county to help identify agricultural producers to attend the focus groups. This deviation has no affect on the project because Clay County is adjacent to Fillmore County and the farms share many of the same agroclimatic characteristics.

IV. Relevance to the Field of Human-Environment Interactions

A. How the results of your project are furthering the field of understanding and analyzing the use of climate information in decision-making

The current understanding of the use of climate information/forecast by agricultural producers has been based on a few surveys focusing on usefulness of forecasts in making agricultural decisions and on potential of using forecasts to improve production. Little attention has been given to the issues of why producers do or do not use forecasts in specific farming decisions, and how an intention of using climate forecasts forms through human psychological processes involving interactions among personality, personal interest and orientation to community, ability of understanding the forecasts, financial ability, and existing government policy. How economic and social environments affect these interactions in development of the intention and its execution? These fundamental questions are addressed in this study. Answers to these questions will further our understanding of decision-making related to use or not use climate forecasts and lead to identifying effective ways to improve the use of climate information in agricultural decision-making.

B. How this research builds on previously funded HDGEC research via other federal agencies

Please see I-D. Some of the projects founded by other federal agencies started earlier than this NOAA project. As depicted in that section these projects are collaborative and interactive and mutually benefiting one another.

C. How is your project explicitly contributing to the following areas of study?

1. Adaptations to long-term climate change

In order to adapting to climate change, the society or a particular community, such as the agricultural community in the Great Plains, needs to not only know the climate change but also use the climate information in their planning and decision-making. Adaptation is established when climate information is integrated in short- and long-term plans and in decision behavior. Thus, the core issue in the adaptation to climate change is how to integrate the climate information in the decision behavior. This study will reveal the decision behavior of agricultural producers in the Great Plains, disclose how much climate information has been used in their decision-making, and identify ways to improve the use of climate information in decision behavior and hence more effective adaptation.

2. Natural hazards mitigation

An effective mitigation of natural hazards is to “plan ahead.” To plan ahead, we need to consider expected future hazardous conditions, e.g., droughts, floods, and tornadoes, and the probability for such conditions to occur, build this information in plans, and execute them accordingly. Again, the decision to build the information in a plan is a decision to use climate forecasts. How much do we use climate forecasts and information and how do we use them in planning? These questions need to be addressed in order to improve mitigation of natural hazards.

This study will address these questions and, by showing ways to improve use of climate forecasts and information, will lead to better mitigation methods.

3. Institutional dimensions of global change

Findings and methods developed from this project will be useful to the National Drought Mitigation Center and the High Plains Regional Climate Center participating in this project. Through their activities the findings could influence governmental and institutional decisions related to climate change.

4. Economic value of climate forecasts

Although a quantitative measure of economic value of using a particular climate forecast will not be calculated in this project, its results will show the bulk of economic value of forecasts. For example, Figures III-7 and III-8 show the expected value of long-term climate forecasts by agricultural producers in choosing best crops for a growing season and for plans to maximize crop revenue in marketing. These decisions involving using climate forecasts will bring economic values to the producers. By improving the use of climate forecasts this project will enhance economic values of climate forecasts to agricultural producers.

5. Developing tools for decision-makers and end-users

This project will lead to improving forecasts' contents and formats to raise the frequency of using climate forecasts by agricultural decision-makers.

6. Sustainability of vulnerable areas and/or people

The Great Plains is a vulnerable area for agriculture and the area's farming community and economy are particularly sensitive to climate change. Establishing a habit and skill of correctly using climate forecasts and information in planning and decision-making is an important strategy to sustain the community and economic development of the area.

7. Matching new scientific information with local/indigenous knowledge

Nebraska is in a unique geographical location with large east-west gradient of precipitation and large north-south gradient of temperature. In this environment, both regional and local weather and climate information is important for decision-making. In this project, our understanding of agricultural producers' perception of local climate information, e.g., those produced by the High Plain Regional Climate Center, will help the Center improve both its local climate information and ways to deliver it to promote the use of the local information in decision-making.

8. The role of public policy in the use of climate information

Findings of this project on concerns and obstacles affecting agricultural producers' use of climate forecasts and information will be useful for revising policies such that they can remove the obstacles and encourage use of climate forecasts and information in decision-making.

9. Socioeconomic impacts of decadal climate variability

While helping establish a habit and skill to use long-term (including decadal scale) climate forecasts and information, this project will help to bring the long-term climate change information into strategic planning, thus either enhancing the favorable climate impact on socioeconomic well being of regional societies or reducing adverse impacts of climate change on regional socioeconomics.

10. Other (e.g., gender issues, ways of communicating uncertain information)

A goal of this project is to improve expressing and communicating the uncertainties associated with climate forecasts and information and to help the end-users of the forecasts, e.g., the agricultural producers, to develop skills to correctly use the forecasts in their decision-making.

V. Graphics

A. Graphic depicting the overall project framework/approach

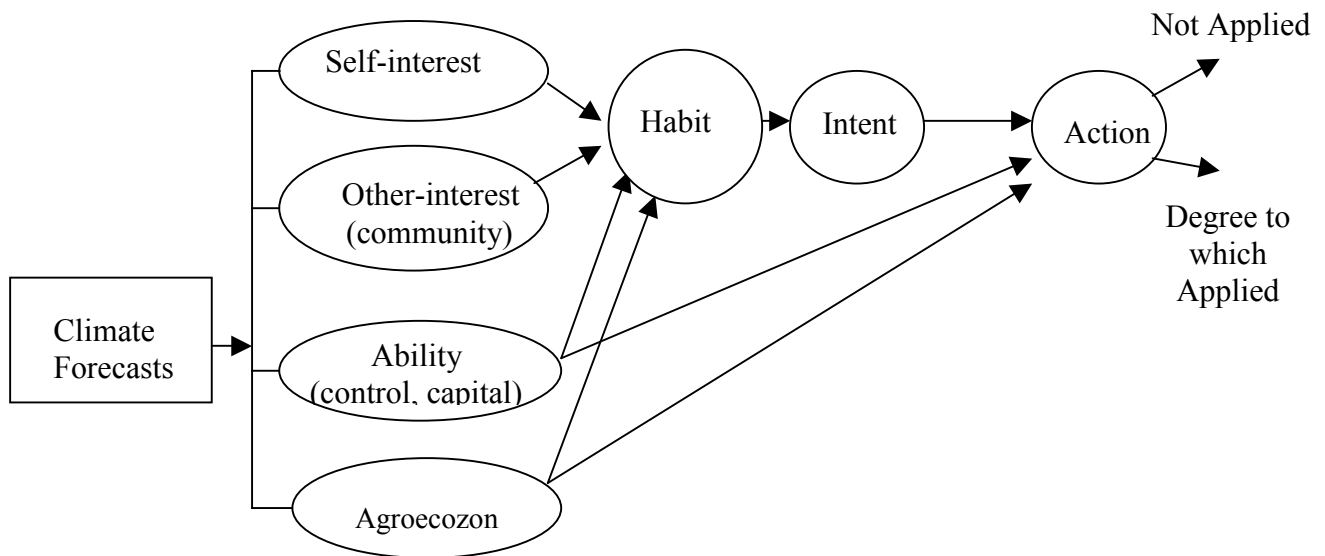


Figure V-1. Intent and action to adopt and apply climate forecast/information.

B. Graphics depicting any key results thus far

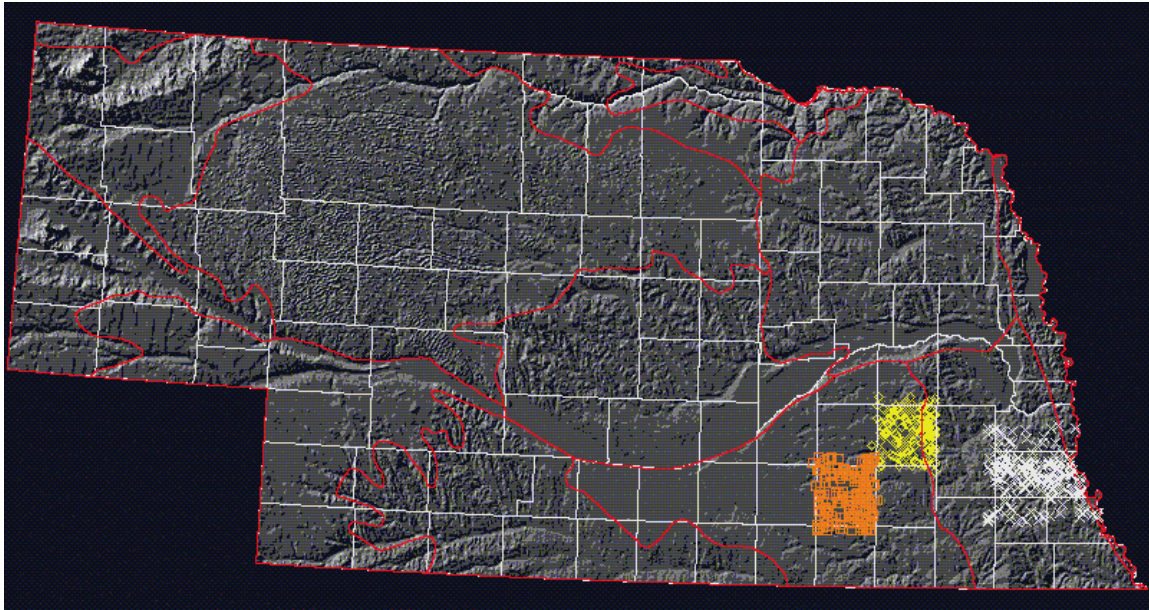


Figure V-2: Geographical reference of the survey population. The red contour lines show the Major Land Resource Areas (MLRAs) in Nebraska.

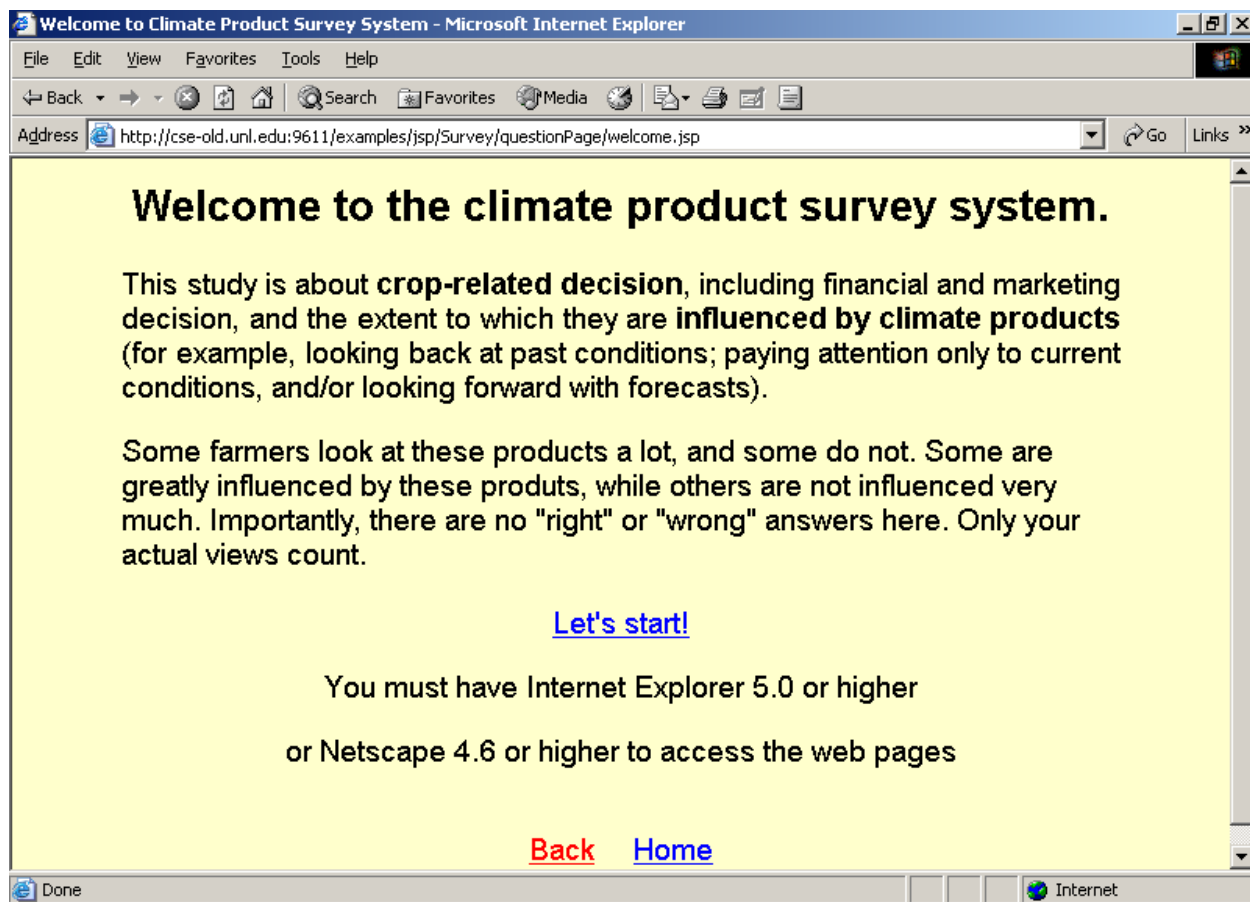


Fig. V-3a: A picture of the web-based survey page showing the survey introduction.

Climate Product Survey System - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print

Address <http://cse-old.unl.edu:9611/examples/jsp/Survey/questionPage/surveyPage.jsp?fSurveyID=1&fPageNo=6> Go Links

10. How often did you look at each of these kind of weather forecasts and information in 2002 for any reason(including farming decisions, recreation, e.g., boating, any other reason)?

head	Never	Very Little	2	Look at it some	4	5	Quite a lot
Type I. Current and Past Conditions							
2001 growing season rainfall in your area	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2001-2002 snow pack in Rocky Mountains	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2001-2002 winter recharge and precipitation in your area	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Current soil temperature	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Crop water use estimates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Quite a lot	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Done Internet

Fig. V-3b: A picture of the web-based survey page showing a question and its answer options.

C. Map of region covered by this study

Nebraska

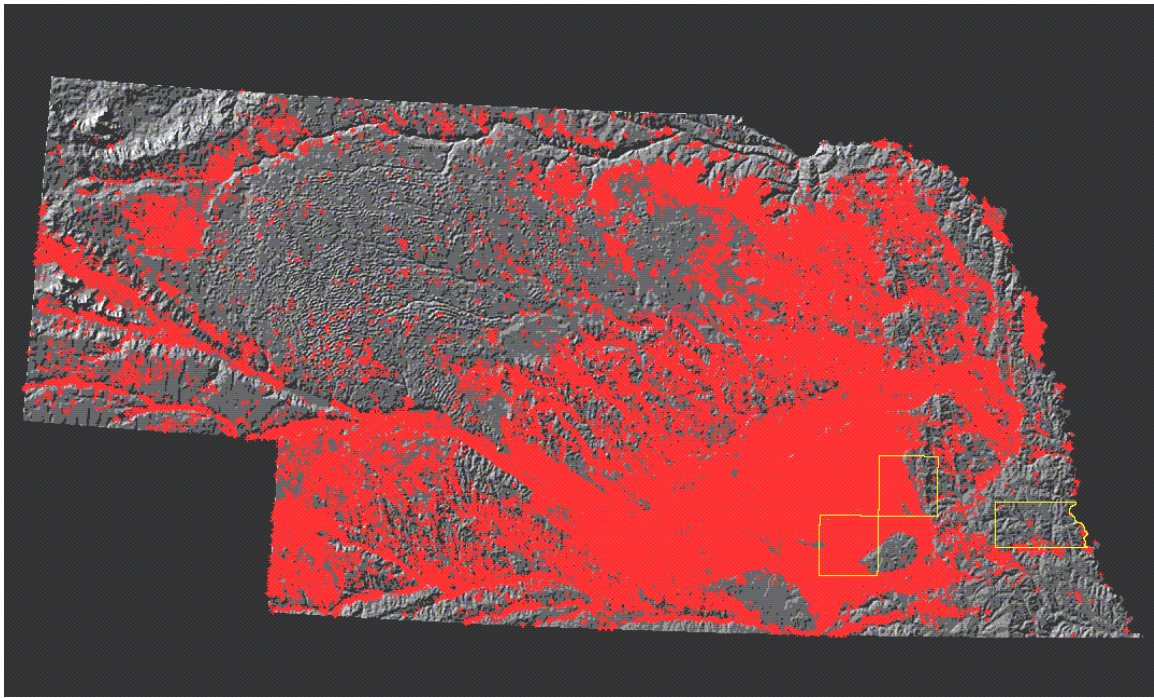
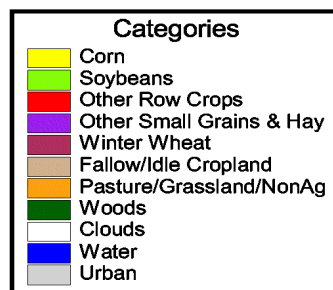
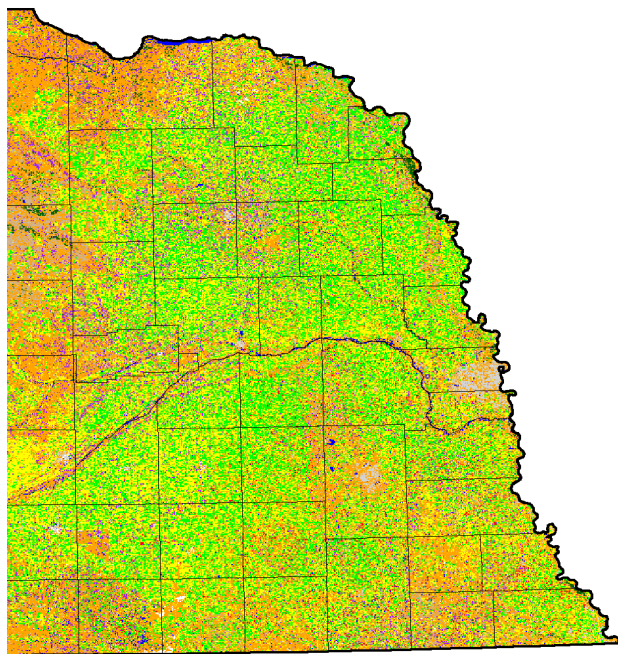


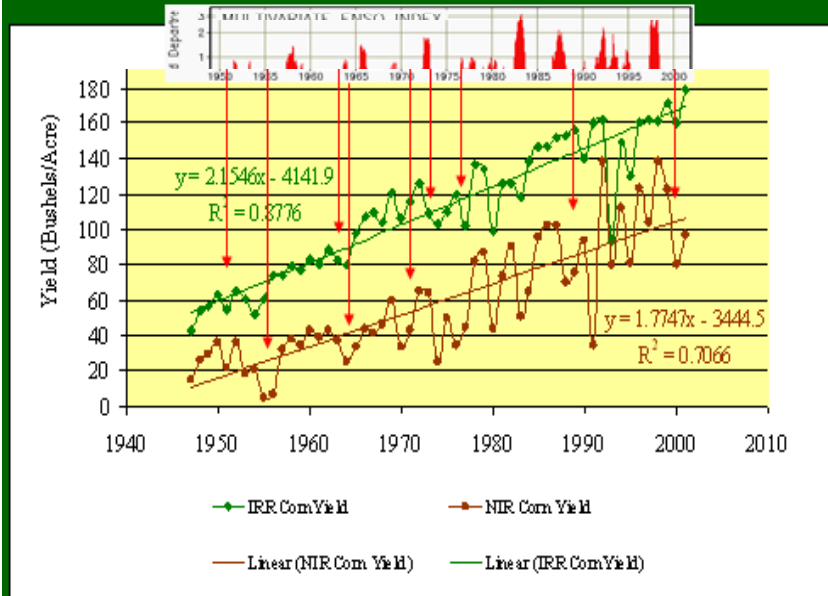
Figure V-4: Three study counties and their geographical location. The three study counties are encompassed by the yellow lines, and are, from west to east, Fillmore, Seward, and Otoe County. They reflect an east-west gradient in the amount of irrigated lands.

D. Graphics from fieldwork to depict study environment



Corn Yields and Droughts

Geneva, Fillmore County



Drought Events

1963-1964 Typic Tempustic
1974 Typic Tempustic
1988-1989 Typic Tempustic
1991 Wet Tempustic
1995 Typic Tempustic
1999-2000 Typic Tempustic

- ◆ Change in yield variability
- ◆ Periods of benign climate
- ◆ Slopes of the trendlines
- ◆ La Nina drought patterns

Genetic Gains and Improved Management

VI. Website address for further information

<http://snrs.unl.edu/noaa-hdgc>